

with its value in its original form, who will find in it valuable additions, interpolated in brackets and in an appendix, which take account of the recent progress of the science.

The newly issued third (and last) volume deals with the great subjects of movement, the production of heat, light and electricity, and the sources and transformations of energy in plants. As in the former volumes, the width and accuracy of the author's acquaintance with the literature of the subjects under treatment are marvellous, and scarcely less so is the power of arrangement by which it is made available to others. The book demands continuous and close attention from its readers, for it is crowded with information condensed so far as it can be without sacrificing clearness. Dr. Ewart deserves thanks for the excellence of the translation, a task the difficulties of which can be appreciated only by those that have attempted to translate a German scientific work into good English, and have experienced how hard it is to do so. He deserves thanks also for wise reticence as regards the introduction of new technical terms, the employment of which is a very real obstacle to the progress of science unless they are required to ensure accuracy. Most parts of botany have suffered more or less from this evil, and it is thus all the greater a pleasure to mark its absence from so fundamental a work as this.

The treatment of each subject is exhaustive and of much interest. While it demands the reader's undivided attention throughout, there is a noteworthy freedom from obscurity in the language, for which thanks are due to both the author and the translator.

Under movement, the causes and mechanism are first discussed in preparation for the consideration of the varied kinds of movements in detail. These are distinguished into movements of curvature, tropic movements, and locomotory and protoplasmic movements. Under the first head are included autonomic movements, the movements of climbers and twiners, those due to mechanical and chemical stimuli, photonastic, thermonastic, and hydronastic curvatures, and the movements connected with dehiscence and dispersal. Tropic movements are treated in a general way, and thereafter, under the various forms, the conditions for and the mechanism of each are dealt with. The movements of protoplasm and its reactions to stimuli are placed under the third head, whether shown by locomotion of the entire cell or by movements of the protoplasm within the cell wall.

The production of heat, light, and electricity by plants is thereafter discussed, and this is followed by a chapter on the sources and transformations of energy in plants, in which it is stated that, "apart from the locomotory movements which are absent from most plants, as many external manifestations of energy are shown in the vegetable kingdom as among animals." How widely different is such a view from that which regarded plants as little more than inert things, possessed of life and able to grow and to reproduce themselves, but far indeed beneath animals in their powers of response to external stimuli.

A brief but very valuable appendix summarising the more important literature on the subject published since the completion of the German edition and an excellent index conclude the work.

It will be seen from this brief abstract that this volume deals with subjects of extreme interest, in which great progress has been made towards a fuller understanding of plants as living organisms sensitive to influences from without, and adapting themselves to their environments. The modern conception of the study of plants has become very much widened and deepened from that which prevailed when that study appeared to content itself with description and classification. Yet there is a danger lest even advance may lead to narrowness of view through the impossibility of acquiring a personal knowledge of more than a limited part of the science of botany. The disadvantages of too great specialisation are to be dreaded, and the benefits conferred by Dr. Pfeffer's "Physiology of Plants" will be felt by systematists and morphologists not less than by physiologists. From it they can gain a clear view of the plant as a living organism, and can estimate the value of such knowledge in relation to their special fields of study. Such a survey will probably bring to light new problems awaiting solution, and will leave the impression that though much has been accomplished deeper problems of life remain unsolved, and that the field of investigation only widens indefinitely. To what has been gathered in its field no better guide can be obtained than that under review.

STEAM AND HYDRAULIC TURBINES.

- (1) *Steam Turbines, with an Appendix on Gas Turbines, and the Future of Heat Engines.* By Dr. A. Stodola. Translated by Dr. Louis C. Loewenstein. Second edition, enlarged and revised. Pp. xix+490. (New York: D. Van Nostrand Co.; London: Archibald Constable and Co., Ltd., 1906.) Price 21s. net.
- (2) *Steam Turbine Engineering.* By T. Stevens and H. M. Hobart. Pp. x+814. (London and New York: Whittaker and Co., 1906.) Price 21s. net.
- (3) *Modern Turbine Practice and Water-power Plants.* By John Wolf Thurso. Pp. xxii+244. (London: Archibald Constable and Co., Ltd., 1906.) Price 16s. net.
- (4) *Hydraulic Motors with Related Subjects, including Centrifugal Pumps, Pipes, and Open Channels.* By Prof. Irving P. Church. Pp. ix+269. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1905.)
- (5) *Turbines.* By W. H. Stuart Garnett. Pp. xiv+283. (London: George Bell and Sons, 1906.) Price 8s. 6d. net.
- (6) *Modern Steam Turbines.* Edited by Arthur R. Liddell. Vol. i. *The Schulz Steam Turbine.* By Max Dietrich. Pp. 73. (London: A. Owen and Co. and T. Fisher Unwin, 1906.) Price 5s.

(1) **T**HIS is the second edition of Dr. Loewenstein's authorised translation of the second edition of Dr. Stodola's well-known treatise. The first edition of the translation was recently fully reviewed

in these columns. The only change in the present edition is the incorporation of a supplement, prepared by the translator, giving the derivation, step by step, of the difficult formulæ in Dr. Stodola's treatise; this supplement will be very acceptable to advanced students in our engineering schools. It is a striking proof of the high estimation in which this text-book is held in the English-speaking world that a second edition of the translation should so soon have been called for.

(2) In their preface Messrs. Stevens and Hobart point out that while a number of treatises on the steam turbine has been published, none of them so far has dealt with the subject from the point of view of the purchaser and user, though to them the question of economy, not only in steam consumption, but also in first cost and maintenance, is of the greatest importance. In the second chapter the authors discuss the much vexed question of units; they abandon the well-known B.Th.U., and adopt for their unit, both for heat energy and mechanical energy, the kilowatt hour, or K.W.H., though expressing an abstract preference for the kilogram-calorie as the unit of energy; similarly for the unit of power they have almost exclusively adopted the kilowatt (K.W.) in preference to the older unit, the horse-power (H.P.).

Since in dealing with the economy of steam turbines the authors have reduced all the results to kilograms of steam per kilowatt hour output from the dynamo driven by the turbine, it is inevitable that they should discard the older units. We do not think, however, that the well-known B.Th.U. will be displaced for many years to come; it is still the unit in which most English-speaking engineers think who have to deal with practical problems connected with the generation of steam, and it has certain practical advantages. That some changes in our system of units will come in course of time we have no doubt, and we have equally no doubt that they will be to the advantage of British and American engineers, though we cannot agree with the somewhat far-fetched hypothesis of the authors that "the rapid rate at which Germany and Switzerland are coming to the front as rivals of English-speaking countries in manufacture and commerce" is due to our present system of units.

To each of the types of turbines which have so far been successful on a commercial scale (De Laval, Parsons, Curtis, Rateau, &c.), and to several others still more or less in an experimental stage, a separate chapter is devoted. In each of these chapters the authors follow a definite procedure; they deal with the turbine, which is being considered, under two heads (not always in the same order):—(a) its economy as a machine for the conversion of heat energy into mechanical energy; (b) its design from the point of view of the user. In the sections devoted to steam economy, the effect of varying the boiler, or admission, pressure, of varying the vacuum, and of superheating the steam is fully treated with the aid of most elaborate and carefully drawn up tables, and curves are plotted from these tables, both at full and half loads, and the thermodynamic losses are analysed; in the portion of each chapter treating of design, the

mechanical principles underlying the design of the turbine under discussion are explained with the aid of a number of reproductions of working drawings, unfortunately on such a small scale as often to render it impossible to make out clearly the details.

An interesting point brought out by the elaborate analysis the authors have made of numerous published tests of De Laval and Parsons turbines is that while in the former a considerable reduction in the weight of steam per kilowatt hour is produced by increasing the boiler pressure, there appears to be but little gain in this respect in the case of the latter when condensing, if the pressure is increased beyond 8 atmospheres, assuming, of course, that the same vacuum is maintained in each case. It is only in the case of the De Laval and of the Parsons turbines that the results of sufficiently numerous tests have been published to enable the authors to discuss fully all the factors which make for economy in any given set of conditions, but they have in all cases given all the information which is so far available for each type of turbine.

In connection with the Rateau turbine, full details are given of the regenerative heat accumulators which have been erected at various works, where the steam working the turbines is the exhaust steam from previously existing reciprocating steam engines. In chapter xiii. are a series of steam tables, both in metric and in English units, from pressures of $\frac{1}{2}$ lb. to 200 lb. per square inch, and two other useful tables, one the calorific values of fuel, the other losses in converting the energy of 1 lb. of coal into electrical energy. Two valuable chapters are xv. and xvi., since in these first typical results are given as to steam economy in modern piston engines, and then the authors enter into an elaborate analysis of the respective merits of the piston engine and the turbine from the point of view of working expenses. They point out that forecasting the future is by no means an easy matter; it is certain, however, that the relative positions of these two types of engines as to economy in steam consumption will depend to a large extent upon the amount to which their special characteristics are developed and utilised, such as the fact that a high vacuum is more beneficial to the turbine than to the piston engine from the point of view of economy, while, as regards superheating, apparently the reverse holds.

The next five chapters deal briefly with such problems as the foundations and engine buildings for turbines, and the cost and arrangement of separate condensing plants, all the data collected in regard to each point being grouped into a series of reference tables. In chapter xxii., a very lengthy one, the authors have brought together in the form of very carefully arranged tables all the published details of some twelve of the largest and most modern steam-turbine plants, and in addition there are some hundred illustrations; the many blank lines in these tables show how difficult it is to obtain information on points of great importance in connection with the planning of such plants.

The final chapter is devoted to marine steam tur-

bines, and the authors have certainly succeeded in bringing together in a convenient form for reference a greater mass of information and data than has ever before been published in any one volume; they have almost attempted to be too up-to-date, as shown in the fact that the new giant Cunarder, recently launched on the Clyde, is called throughout *Susitania* instead of *Lusitania*. A valuable bibliography and a complete index conclude a volume which must have involved immense labour in the compilation of the masses of figures with which its pages bristle, and in the preparation of the carefully drawn curves which pictorially represent so many of these elaborate tables; it will undoubtedly for many years be one of the standard works of reference on the steam turbine.

(3) This work does not treat of the design of turbines, but gives such information in regard to modern water turbines and their installation as will be required by an engineer engaged in preparing plans for a proposed water-power plant. In view of the fact that hitherto there have existed so far in hydraulic-power engineering no generally accepted terms, the author explains in an introduction all the terms he uses, gives a careful definition of each, and suggests that the nomenclature he has used might be generally adopted; it would certainly be a great boon to the student if the authors of text-books on turbines would conform to some definite and fixed nomenclature, both in dealing with the theory and also in explaining the mechanical construction of these machines.

The first two chapters are devoted to an account of modern turbine practice in Europe and in America, and Mr. Thurso is of opinion that not only have there been marked differences in the development of the turbine in the two continents, but that, on the whole, development has proceeded on more scientific lines in Europe, and much greater mechanical skill has been shown by the turbine builders of that continent in turning out highly-finished machines. Up to a few years ago the axial-flow machine was the standard type of European builders, but the difficulty of regulating its speed, and the application of the turbine to the generation of electrical energy, which necessitated higher speeds and closer regulation, has led to the almost complete abandonment of this type, and to the adoption of some form of radial-flow turbine, the actual form adopted varying with the head of water available. In America, the author points out, development has been on quite different lines; the modern turbine is a descendant of the radial inward-flow, or vortex, turbine of J. B. Francis; but, since the number of revolutions varies as the square root of the head of water, and since for the same head the revolutions of different machines will vary inversely as their diameter, the tendency has been, owing to the demand for high speed, to reduce the diameter, and thus to reduce the interior space available for the water to turn and escape axially when its work is done. It has thus become necessary to turn the water in an axial direction while still in the runner-bucket, that is, to curve gradually the runner-bucket from a radial to an axial direction, giving

these latter a very complicated form, and simultaneously with this there has been a tendency to increase the axial dimensions of the bucket entrances.

Up to a low head, say of 40 feet, the author is of opinion that the American turbine has great advantages over all others in common use, but for high heads he considers it is unsuitable, and that it cannot successfully compete with European types; he is also of opinion that the quality of workmanship and of materials used by American turbine builders is distinctly second-class, due no doubt to the existence of abundant water-power in all parts of the country, and to the belief of the average purchaser that water-power costs little or nothing, and that, therefore, any turbine which will run is good enough for his purpose. He also considers that the practice of testing turbines in the flume at Holyoke, where the head is only 18 feet, has been prejudicial to development, since a good result on the test-bed by no means ensures a similar result when the machine is set up in the place where it is to work, often under heads far greater than those available at Holyoke.

In chapter iii. the various types of turbines are classified, and the general properties and characteristics of each class are briefly discussed; then follows the only chapter devoted to the steam turbine, and, in view of the small amount of space devoted to it, the inclusion of this chapter in the book has been clearly a mistake; it would have been much wiser if the author had omitted the steam turbine altogether, and had devoted the space thus set free to enlarging those portions of the book dealing with the accessories of turbines.

The remainder of the book deals with modern types of water turbines, their construction, and the various accessories attached to them for the purpose of admitting and exhausting the water, governing their speed, &c., and the decided opinion is expressed that, unless there is some definite reason to the contrary, horizontal shafts should always be adopted; a number of illustrations is given of large turbine plants recently erected in America and in Europe, and the essential points in the design of each are clearly set forth.

The chapters on the accessories, &c., are especially valuable, as these details are often either neglected in text-books or treated in a very perfunctory fashion; the data given by the author will be found very valuable by all engineers engaged in planning water-power schemes, and they embody the results of wide experience of various classes of turbines; such important points as the difficulties induced by the formation of ice on a large scale and the means to be adopted to cope with them, and the measurement of water for selling power are fully dealt with.

A paper by Mr. A. V. Garratt on the elements of design favourable to speed regulation in plants driven by water-power is printed in the form of an appendix; the whole book is thoroughly up to date in its information, the facts and data are well marshalled, and it should be consulted by every engineer who may be called upon to deal with the problem of the utilisation of water-power.

(4) The great increase in the utilisation of water-power in all parts of the world, mainly in connection with the electric transmission of energy, has led to much more attention being devoted to this branch of engineering in all technical colleges, and this has naturally brought about a demand for text-books thoroughly up to date, and suited to modern developments of the industry. Prof. Church has attempted both to supply this need on the part of engineering students, and at the same time to write a book which will be of service to practising engineers; the subject has been treated by him, therefore, both from the theoretical and from the practical standpoint.

After dealing with the general considerations which govern the design of all types of hydraulic motors, one chapter is devoted to the various forms of gravity motors—overshot, breast, and undershot wheels—which have been so largely displaced in modern days by the turbine. Before dealing with turbine design the author shows that there are three theorems which lie at the basis of the theory of turbines and centrifugal pumps; these theorems are, in fact, fundamental principles of mechanics, though the third presupposes the existence of “steady flow”; this third theorem may be expressed as follows:—

“Power of a turbine in steady motion = angular velocity $\times$ change of angular momentum experienced by the mass of water flowing per unit of time in its passage through the turbine.”

These theorems are illustrated by a series of numerical examples worked out in full.

In chapter iv. impulse wheels are considered, and the Pelton and the Girard impulse wheels are taken as illustrations of this type; in the next chapter the turbine proper, or “reaction turbine,” is taken up, and as a preliminary to the discussion of the modern turbine the theory of the Barker’s mill is deduced; it is then shown that the Fourneyron turbine is a direct descendant of this old and simple form, and the theory of the Fourneyron form is then worked out both when friction is disregarded and when it is taken into account. Prof. Church then classifies turbines under four heads—(1) radial outward-flow, (2) radial inward-flow, (3) axial flow, (4) mixed flow—and deals with each of these classes in detail; he gives descriptions, with excellent illustrations, of well-known makes of each type, and concludes the chapter with the general theory of reaction turbines. The testing and regulating of turbines form the subject-matter of chapter vi., and a description is given of the Holyoke testing flume. The following chapter is devoted to the theory and construction of centrifugal pumps, and the formulæ deduced are illustrated by working out in full numerical examples.

The flow of water over weirs and through pipes and open channels is treated mainly from the point of view of the designer of turbine machinery, and in connection with this portion of the book there is a series of useful diagrams in the appendix for Kutter’s coefficient, &c.

The book concludes with a chapter on pressure

engines, hydraulic rams and accumulators, the Worthington water-motor pump and the Brotherhood pressure engine being taken as examples. Prof. Church’s book will undoubtedly be a recognised text-book for advanced engineering students.

(5) This book, originally intended to give a popular account of the history, construction, and operation both of water and steam turbines, has been extended in its scope, and the author has dealt with the important problem of blade design in such a way as to make it a text-book useful also to the technical student. After giving a brief history of the evolution of the water turbine, the conditions which must be fulfilled if such machines are to be efficient are fully discussed; then follow several chapters in which recent modern types of both impulse and reaction turbines are described with the help of a series of good illustrations; finally, this half of the book concludes with some details of the best methods of erecting water turbines and controlling them by governors.

In part ii. the steam turbine is taken up, and naturally attention is chiefly devoted to the Parsons, De Laval, and Curtis turbines, as these are practically the three types which have so far been commercially successful; a full description is given of the principles underlying the design, and of the methods adopted in manufacturing the various parts of each of these well-known engines, and it is to be hoped that a study of this part of the book may do something to dissipate the extraordinary ignorance and misconception which prevail among men, even of fair mechanical knowledge, in regard to the steam turbine and its possibilities. Special chapters are devoted to the application of the turbine to marine purposes, and a clear account is given of the rapid development in this field of work during the last few years both in the Royal Navy and in the merchant service. Turbo-blowers and rotary pumps are discussed in another chapter, and the advantages of these pumps over reciprocating pumps, where vast volumes of air have to be supplied, as is the case in connection with the blast-furnace industry, are clearly set forth.

A series of appendices dealing briefly with the mathematical and mechanical principles involved in elementary engineering, with fluid motion, and with the behaviour of gas, conclude a book which will do much, it is probable, to make the layman take a more intelligent interest in this the latest and most striking development of the skill of the mechanical engineer.

(6) This is an authorised translation of a book by Herr Dietrich, in which he describes the various patents for steam turbines and their accessories taken out by Mr. R. Schulz, engine-works manager of the Germania Shipyard at Kiel, and also the results of tests of the Schulz turbine, both when used for marine work and for the generation of electrical energy.

The rest of the book is devoted to *ex parte* statements in reference to the controversy between Mr. Parsons and Mr. Schulz in regard to their respective inventions, which was eventually fought out in the Law Courts in an action brought for infringement of

patent rights. It is not our province to enter into the details of this controversy; we need only say that Mr. Schulz claims that he has succeeded better than any other inventor in solving the difficult problem of designing a practical and not too complicated turbine in which the steam consumption per horse-power hour is economical, not only at full power, but also when the engine is working at low loads, and he also claims that he has simplified the arrangements necessary on board ship, where go-astern machines must be provided as well as the go-ahead turbines. The author gives a clear description of the mechanical details by which the inventor has secured the results he claims. This book should be carefully studied by all those interested in the history of the development of the steam turbine.

T. H. B.

OUR BOOK SHELF.

Ueber chitinöse Fortbewegungs-Apparate einiger (insbesondere fussloser) Insektenlarven. By Dr. Wilhelm Leisewitz. Pp. iv+143; with 46 illustrations in the text. (Munich: C. Reinhardt, 1906.) Price 4 marks.

THE author commenced his observations with the terminal appendage in the larva of *Xiphydria dromedarius*. This larva, which is almost apterous, lives in galleries in rotten wood, and the appendage is used firstly as a prop and partly to compress the loose substance behind it to give it a firm support as it gradually progresses by gnawing away the wood in front. He then extended his researches to the hairs, bristles, &c., of other internal-feeding larvæ, especially those which are apterous or subapterous, and in this small volume we have the results of his careful investigations.

The chitinous appendages used for locomotion by such larvæ consist chiefly of (1) undifferentiated hairs, (2) spines, (3) warts, and (4) bristles. Where the larvæ live in hard substances, like wood or bark, the appendages consist of short, stiff hairs or spines and warts, but when the larvæ live in soft substances like rotten wood or mould, they are provided with long, slender hairs or bristles of varying form.

The greater portion of the essay is devoted to larvæ of Coleoptera, though a few others belonging to the orders Neuroptera, Lepidoptera, Diptera, and Hymenoptera are also noticed.

Apart from the physiological interest of the inquiry, it is also of some importance to the systematist; for the author claims to have discovered trustworthy characters in the chitinous appendages, which will allow many species of Coleoptera, hitherto supposed to be indeterminable in the larval state, to be easily recognised.

W. F. KIRBY.

Map of the British Isles. Constructed by W. and A. K. Johnston. Size 72 inches x 63 inches. Mounted on cloth with rollers and varnished. (London: W. and A. K. Johnston, 1906.) Price 21s.

THE teaching of geography has received much attention in recent years, and the increased importance given to the subjects in schools has led to the production of several new series of excellent wall maps. The present map is a new addition to one of these series. It is boldly printed, and coloured in a manner to make it easily visible in all parts of a large classroom. The scale is 1:633,600, or ten miles to an

inch. The populations of the different towns are indicated by means of symbols, but it is to be feared that these will be of little use to anybody but the teacher. The map will require to be supplemented by an orographical one if the physical geography of our country is to be studied satisfactorily.

LETTER TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Production of Radium from Actinium.

THE experimental evidence on the growth of radium from uranium has in the past been somewhat conflicting. Both Mr. Soddy and Mr. Whetham have stated that they observed an increase with the time in the amount of radium in solutions of certain uranium salts which were under examination. The writer, however, was able to show that, starting with a solution of uranium nitrate carefully purified by repeated crystallisation, the amount of radium formed in an interval of eighteen months was less than one two-thousandth of the amount which was to be expected from the disintegration theory.

I think that this discrepancy is readily explained by the results of an experiment which I have just made on the growth of radium from actinium. A kilogram of carnotite ore containing about 20 per cent of uranium was decomposed with an excess of dilute hydrochloric acid, and the solution thus obtained was treated with hydrogen sulphide, the precipitated sulphides being subsequently removed by filtration. To the solution was then added a fraction of a gram of thorium nitrate, followed by a solution of several grams of oxalic acid. After standing for several days, the slight precipitate which formed was completely removed and converted into a soluble nitrate. The nitrate in dilute solution was again treated with an excess of oxalic acid, and this second precipitate was converted into a soluble chloride. I have found from a considerable number of experiments that practically all the actinium contained in a uranium mineral can be separated in this manner.

The solution of the chlorides containing the actinium was sealed up in a glass bulb, and about two months later, on April 25 last, the gases and emanation were boiled out and collected. After standing for some minutes the gas was introduced into an electroscope. The activity of the emanation corresponded to a content of 5.7×10^{-9} gram of radium in the actinium solution. The bulb was again sealed, and was allowed to remain undisturbed until to-day, when the radium emanation present was again removed and tested. The amount of radium emanation now found corresponds to 14.2×10^{-9} gram of radium, indicating that there has been formed in the solution during this interval of 193 days a quantity of radium equal to 8.5×10^{-9} gram. This is equivalent to the production of about 1.6×10^{-8} gram of radium in one year, and since the amount of radium in equilibrium with 200 grams of uranium is 7.6×10^{-5} gram, the value of $\lambda(\text{year})^{-1}$ for radium can be calculated, and is given as 2.2×10^{-1} . The indicated half-value period would be about 3100 years. This number can only be regarded as approximate at present, since the original content of uranium in the material used, and the completeness of the separation of the actinium, are both uncertain. I think, however, that another step has been made towards the solution of the somewhat complex problem of the genesis of radium, and, since the amount of actinium in a mineral is apparently always proportional to the amounts of uranium and radium present, that actinium will prove to be the looked-for intermediate product.

BERTRAM B. BOLTWOOD.

Sloane Laboratory of Yale College, New Haven, Conn., November 5.